Flue Gas Desulphurisation with SIMONA® PP-H 100 AlphaPlus Pipes
## Project Data

<table>
<thead>
<tr>
<th><strong>Project</strong></th>
<th>Renewal of the Flue Gas Desulphurisation Plant (FGDP) at Niederaussem Power Station with blast lances made of SIMONA® PP-H 100 AlphaPlus</th>
</tr>
</thead>
</table>
| **Requirements** | Chemical and abrasive stress externally and internally  
Medium: HCl, SO₂, HF, milk of lime-gypsum suspension, pH 3–4  
Solids content: approx. 12 %–15 %  
Service pressure: approx. 0.5 bar  
Service temperature: approx. 70 °C |
| **Client** | RWE Energie AG, Niederaussem Power Station  
Installed power: 3864 MW in 9 blocks, lignite demand: 21.2 mill. t/a |
| **General contractor** | K & W Knäpper & Witt GmbH, Nordkirchen-Capelle |
| **Subcontractor** | ATEA GmbH, Ransbach-Baubach |
| **Plastic construction** | KTW GmbH & Co. KG, Ransbach-Baubach |
| **Project management** | ATEA GmbH, Ransbach-Baubach |
| **Assembly** | Applications Technology Dept., SIMONA AG, 55606 Kirn |
| **Connection systems** | Heated tool butt welding in accordance with DVS 2207-11  
Extrusion welding in accordance with DVS 2207-4  
Hot-gas string bead welding in accordance with DVS 2207  
Socket connections on site with lip seals |
| **Products used** | SIMONA® PP-H 100 AlphaPlus pipes, d 110 – d 500, SDR 11, length = 5 m  
SIMONA® PP-H 100 AlphaPlus fittings: tees, reducers, flanges  
SIMONA® PP-DWU sheets |
| **Time** | 2004 |
Owing to the high load of combustion gases on the flue-gas desulphurisation plant in Niederaussem, RWE Energie AG decided on renovation. On account of corrosion the rubber-lined steel pipes generally have a service life of 5 to 8 years.

For this reason a search was conducted for material which would be able to replace the rubber-lined steel pipes previously used as blast lances. The new material would have to have a longer service life and ensure a high degree of operational reliability, and thus reduce running costs. Therefore RWE Energie AG decided in favour of SIMONA® PP-H 100 AlphaPlus – a material which meets all the criteria.

The flue gas desulphurisation plants (FGDP) remove acid and aggressive pollutants such as HCl, SO₂ and HF gases from the combustion gases of the power station using a pH-controlled scrubbing liquid. The scrubbing liquid for the flue gas desulphurisation plants consists of dissolved and undissolved lime as well as gypsum components which arise from chemical absorption of the lime with SO₂ pollutants. In lignite power stations the scrubbing liquid has a temperature approx. 70 °C and a pH between 3 and 4. Owing to the acid potential and the moist atmosphere at increased temperature steel components must be protected against corrosion very effectively. On account of the gypsum-milk of lime suspension the pipelines are also subjected to abrasion.

When the lignite power stations were upgraded with flue gas scrubbers in 1987 to 1988, various grades of soft rubber were used to line the scrubbing towers made of black steel and for the suspension-carrying pipes.
The good mechanical properties also qualified SIMONA® PP-H 100 AlphaPlus as an ideal structural material. In a short-time tensile test high moduli of elasticity were measured up to a temperature of 100 °C (see Fig. 1).

The material SIMONA® PP-H 100 AlphaPlus has very good chemical resistance to organic and inorganic acids, alkalis and solvents up to temperatures of 100 °C. The media occurring in the absorption scrubbers, such as hydrochloric acid and sulphuric acid, have no influence on the service capability of SIMONA® PP-H 100 AlphaPlus for many years. That is why from a chemical aspect long service lives are to be expected. For many decades PP-H 100 has been successfully used in the chemical industry and in pickling and regenerating systems for precisely that reason. As a result, in many sectors PP-H 100 has replaced metal materials, which often have very short service lives owing to increased corrosion. SIMCHEM 5.0, our CD-ROM catalogue for chemical resistance offers detailed information on the corrosion resistance of SIMONA® products.

The high abrasion resistance of SIMONA® PP-H 100 AlphaPlus was demonstrated in various laboratory tests and practical experiments. For example, in a sand-slurry test the indoor wear of pipes was simulated and a high wear resistance was demonstrated in comparison with other materials. In addition, in a spray test, which simulates outdoor wear, the high wear resistance of PP-H 100 to erosion was measured by spraying the surface with an abrasive liquid (see Fig. 2).
Advantages confirmed in empirical test
Suspension-carrying PP-H 100 liner pipes confirmed the excellent laboratory results in a two-year test at a power station. It was also demonstrated that owing to the use of plastic pipes a higher level of cost-effectiveness is achieved compared with rubber-lined steel pipes. Owing to the very low surface roughness $R_\text{a}$ of SIMONA® PP-H 100 AlphaPlus pipes amounting to less than 0.4 µm the flow resistance, and hence pressure loss, is reduced by up to 10 per cent depending on the velocity of flow.

The actual starting position at Niederaussem lignite power station
The lignite power station operated by RWE Energie AG in Niederaussem has a capacity of 3864 MW. Of that figure 1,000 MW are generated at an efficiency of over 43% in a plant (BoA I) which was commissioned in 2002. The old plants operate at an efficiency of more than 31%.

The combustion flue gases are cleaned in special scrubbers using appropriate wet processes. Desulphurisation is performed using milk of lime, which is sprayed in a fine current of mist flowing counter to the flue gas. Tapered nozzles made of silicon carbide (SiC), which are attached to the branches of the blast lances, generate the spray. The reaction product occurring is gypsum, which, in the purity produced here, is ideal for the construction industry.

In Niederaussem the old flue gas desulphurisation plants had to be completely renovated owing to the long service life. Consequently, the steel scrubbers with a diameter of approx. 20 m and a height of approx. 40 m were relined inside and the blast pipes made of rubber-lined steel (St37) were completely replaced by SIMONA® PP-H 100 AlphaPlus blast pipes. The number of nozzle levels was reduced from five to four because this was acceptable in terms of process engineering.

3: Blast lance components made of SIMONA® PP-H 100 AlphaPlus
4: Extrusion welds on the branches for the nozzles
5: Lifting of a prefabricated nozzle lance
6: Assembled nozzle level
Manufacturing the blast lances

The blast lances are made from pipes with graduated diameters. As a result, the nozzles can be subjected to virtually constant pressure over the entire length of the pipes. The largest diameter is 500 mm outside and the smallest diameter is 110 mm. Diameter is reduced in up to four stages.

The reducers and nozzle connection pipes are positioned below the lance so that complete emptying takes place on shutdown. In addition, the reducers are arranged off-centre so that flow resistance is reduced at the bottom and turbulence is avoided. The pipes and interconnecting sockets were connected to one another by heated tool butt welding (Fig. 4).

Welding of the branches to the main pipe was conducted by extrusion welding. The fixed flange and the pipe segments were also connected to one another by heated tool butt welding.

In order to absorb the heavy weight of the tapered nozzles amounting to about 7 kg a sheet 20 mm thick was welded between two opposite branches. This ensures that the nozzles always retain their position, even at a temperature of 70 °C. There have already been positive experiences with this design for several years. In order to increase service lives in the light of abrasion, all the welding flash and edge projections inside the pipes were removed or levelled. Consequently, turbulence behind the welding flash or edges is prevented, which might lead to increased erosion at a flow velocity of 2–3 m/s.

Assembly of the blast lances on site

The blast lance parts delivered were introduced to the tank through a manhole near the bottom. The nozzle levels above a height of 28 m were completely clad, with the exception of an opening through which the pipe parts were hoisted to the various working levels using a block and tackle.

The pipes were supported by the existing steel girders, which had been fitted at intervals of 2 m (Fig. 6). The pipes were sized so that the bowing of the pipes is negligible when exposed to a temperature of 70 °C and completely filled with a milk of lime-gypsum suspension. The pipes with a diameter of 500 mm were therefore sized with a wall thickness of > 45 mm. Where bowing was expected to be higher, axial reinforcements were provided.

The blast lances were firmly connected to the supply pipes by means of flange assemblies. They lie on steel girders and can move freely in an axial direction.

To support the pipes special channels were made using SIMONA® PP-DWU sheets, which were attached to the I-beams with PP bolts (Fig. 8). They ensure that the pipes can move in an axial direction. This movement is chiefly caused by thermal expansion, which is approximately twelve times greater than that of steel. At the ends of the blast pipes there are sliding bearings in order to prevent stresses and strains from building up on account of thermal expansion by the pipes.
The individual pipes prefabricated at the workshop were connected to one another using special interconnecting sockets. To make sure the socket connections remain tight even in the event of tensile loads and do not become detached during vibrations, they were secured with safety bolts to prevent axial forces (Fig. 9).

After an installation period of about two weeks all the scaffolding was removed. Then the mist collectors made of SIMONA® PP-DWU sheets were fitted above the nozzle levels. Finally, the scrubber was put into service again, so cleaned flue gases were able to leave the chimney again after only three weeks.

**Literature**

Dr. Boris Gibbesch:
Practical Experiences of Plastic Pipes in Flue Gas Desulphurisation Plants; specialist conference "Corrosion Protection in Flue Gas Desulphurisation Plants" in Essen, 1997

Dr. B. Gibbesch, M. Schütz, St. Müller:
Use of PP/GRP composite structures in suspension-carrying pipes of a flue gas desulphurisation plant, VGB Kraftwerkstechnik 6/98, P. 103–111

7: During installation of the pipes at one level: the various pipe segments were sized so that it would be possible to have them assembled by four persons
8: Channel support made of SIMONA® PP-DWU sheets
9: Sliding bearing at the end of the blast lance in order to absorb thermal expansion
10: View of the nozzle levels from below, revealing the size of the scrubbing towers
Range of Products

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Pipes, fittings, valves

Available ex stock

| Polypropylene, homopolymer, grey RAL 7032 |

Properties

- High impact resistance
- High chemical resistance (excellent in contact with many acids, alkalis and solvents)
- Maximum tension crack resistance
- Corrosion resistance
- Good hydraulic properties due to smooth interior pipe surfaces (no deposits)
- Physiological safety

For production reasons individual sizes of injection-moulded fittings are also manufactured in PP-R 80.
Semi-finished Products

**Standard articles**

<table>
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<th>Description</th>
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<tbody>
<tr>
<td>PP-DWU</td>
<td>Homopolymer, permanent-heat resistant, grey</td>
</tr>
<tr>
<td>PP-DWU-SK</td>
<td>Homopolymer, permanent-heat resistant, grey, polyester-backed</td>
</tr>
</tbody>
</table>

**Available on request**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td>PP-DWU-B</td>
<td>Homopolymer, permanent-heat resistant, grey, for tanks requiring mandatory test certificates</td>
</tr>
<tr>
<td>PP-DWU-GK</td>
<td>Homopolymer, permanent-heat resistant, grey, glass fibre-backed</td>
</tr>
</tbody>
</table>

### Properties

- High chemical resistance (excellent in contact with many acids, alkalis and solvents)
- Permanent-heat resistance
- Corrosion resistance
- Excellent processing capability
- Physiological safety

For further information about application issues please contact our Applications Technology Department:
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- Pipes and Fittings Brochure
- SIMPLAST 1.0
- SIMCAT 3.1
- SIMCHEM 3.0
- Semi-finished Products for Tank/Vessel Construction Brochure

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We look forward to assisting you